W O R L D W I D E
wwPDB
P R O T E I N   D A T A   B A N K

wwPDB X-ray Structure Validation Summary Report (i)

Jun 7, 2020 – 04:51 am BST

PDB ID	:	6I4Z
Title	:	Crystal structure of the disease-causing P453L mutant of the human dihydrolipoamide dehydrogenase
Authors	:	Szabo, E.; Wilk, P.; Torocsik, B.; Weiss, M.S.; Adam-Vizi, V.; Ambrus, A.
Deposited on	:	2018-11-12
Resolution	:	2.34 Å(reported)

This is a wwPDB X-ray Structure Validation Summary Report for a publicly released PDB entry.

We welcome your comments at validation@mail.wwpdb.org
A user guide is available at
https://www.wwpdb.org/validation/2017/XrayValidationReportHelp
with specific help available everywhere you see the (i) symbol.

The following versions of software and data (see references (i)) were used in the production of this report:

|		
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.11
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.11

1 Overall quality at a glance ⓘ

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 2.34 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.
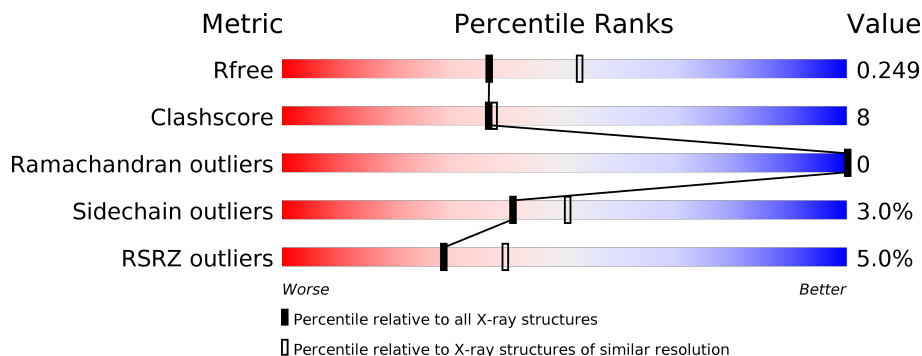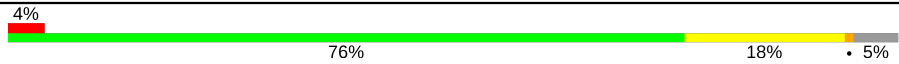

Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	2096 (2.36-2.32)
Clashscore	141614	2193 (2.36-2.32)
Ramachandran outliers	138981	2159 (2.36-2.32)
Sidechain outliers	138945	2160 (2.36-2.32)
RSRZ outliers	127900	2067 (2.36-2.32)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments on the lower bar indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions <=5% The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	496	82% 12% • 5%
1	B	496	6% 77% 18% • 5%
1	C	496	84% 10% • 5%
1	D	496	10% 75% 19% • 5%
1	E	496	6% 77% 18% 5%
1	F	496	6% 79% 16% • 5%

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Mol	Chain	Length	Quality of chain
1	G	496	4% 76% 18% 5%
1	H	496	6% 83% 12% 5%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
3	SO4	C	506	-	-	X	-
3	SO4	E	502	-	-	X	-
3	SO4	G	503	-	-	X	-

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 57894 atoms, of which 28801 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called Dihydrolipoyl dehydrogenase, mitochondrial.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	472	Total 7087	C 2215	H 3573	N 607	O 673	S 19	0	1	0
1	B	472	Total 7086	C 2215	H 3572	N 607	O 673	S 19	0	1	0
1	C	472	Total 7075	C 2211	H 3567	N 607	O 671	S 19	0	0	0
1	D	472	Total 7075	C 2211	H 3567	N 607	O 671	S 19	0	0	0
1	E	472	Total 7086	C 2215	H 3572	N 607	O 673	S 19	0	1	0
1	F	472	Total 7075	C 2211	H 3567	N 607	O 671	S 19	0	0	0
1	G	472	Total 7076	C 2211	H 3568	N 607	O 671	S 19	0	0	0
1	H	472	Total 7075	C 2211	H 3567	N 607	O 671	S 19	0	0	0

There are 184 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-21	MET	-	initiating methionine	UNP P09622
A	-20	ALA	-	expression tag	UNP P09622
A	-19	SER	-	expression tag	UNP P09622
A	-18	TRP	-	expression tag	UNP P09622
A	-17	SER	-	expression tag	UNP P09622
A	-16	HIS	-	expression tag	UNP P09622
A	-15	PRO	-	expression tag	UNP P09622
A	-14	GLN	-	expression tag	UNP P09622
A	-13	PHE	-	expression tag	UNP P09622
A	-12	GLU	-	expression tag	UNP P09622
A	-11	LYS	-	expression tag	UNP P09622
A	-10	GLY	-	expression tag	UNP P09622
A	-9	ALA	-	expression tag	UNP P09622

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Chain	Residue	Modelled	Actual	Comment	Reference
A	-8	LEU	-	expression tag	UNP P09622
A	-7	GLU	-	expression tag	UNP P09622
A	-6	VAL	-	expression tag	UNP P09622
A	-5	LEU	-	expression tag	UNP P09622
A	-4	PHE	-	expression tag	UNP P09622
A	-3	GLN	-	expression tag	UNP P09622
A	-2	GLY	-	expression tag	UNP P09622
A	-1	PRO	-	expression tag	UNP P09622
A	0	GLY	-	expression tag	UNP P09622
A	453	LEU	PRO	engineered mutation	UNP P09622
B	-21	MET	-	initiating methionine	UNP P09622
B	-20	ALA	-	expression tag	UNP P09622
B	-19	SER	-	expression tag	UNP P09622
B	-18	TRP	-	expression tag	UNP P09622
B	-17	SER	-	expression tag	UNP P09622
B	-16	HIS	-	expression tag	UNP P09622
B	-15	PRO	-	expression tag	UNP P09622
B	-14	GLN	-	expression tag	UNP P09622
B	-13	PHE	-	expression tag	UNP P09622
B	-12	GLU	-	expression tag	UNP P09622
B	-11	LYS	-	expression tag	UNP P09622
B	-10	GLY	-	expression tag	UNP P09622
B	-9	ALA	-	expression tag	UNP P09622
B	-8	LEU	-	expression tag	UNP P09622
B	-7	GLU	-	expression tag	UNP P09622
B	-6	VAL	-	expression tag	UNP P09622
B	-5	LEU	-	expression tag	UNP P09622
B	-4	PHE	-	expression tag	UNP P09622
B	-3	GLN	-	expression tag	UNP P09622
B	-2	GLY	-	expression tag	UNP P09622
B	-1	PRO	-	expression tag	UNP P09622
B	0	GLY	-	expression tag	UNP P09622
B	453	LEU	PRO	engineered mutation	UNP P09622
C	-21	MET	-	initiating methionine	UNP P09622
C	-20	ALA	-	expression tag	UNP P09622
C	-19	SER	-	expression tag	UNP P09622
C	-18	TRP	-	expression tag	UNP P09622
C	-17	SER	-	expression tag	UNP P09622
C	-16	HIS	-	expression tag	UNP P09622
C	-15	PRO	-	expression tag	UNP P09622
C	-14	GLN	-	expression tag	UNP P09622
C	-13	PHE	-	expression tag	UNP P09622

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| Chain	Residue	Modelled	Actual	Comment	Reference
C	-12	GLU	-	expression tag	UNP P09622
C	-11	LYS	-	expression tag	UNP P09622
C	-10	GLY	-	expression tag	UNP P09622
C	-9	ALA	-	expression tag	UNP P09622
C	-8	LEU	-	expression tag	UNP P09622
C	-7	GLU	-	expression tag	UNP P09622
C	-6	VAL	-	expression tag	UNP P09622
C	-5	LEU	-	expression tag	UNP P09622
C	-4	PHE	-	expression tag	UNP P09622
C	-3	GLN	-	expression tag	UNP P09622
C	-2	GLY	-	expression tag	UNP P09622
C	-1	PRO	-	expression tag	UNP P09622
C	0	GLY	-	expression tag	UNP P09622
C	453	LEU	PRO	engineered mutation	UNP P09622
D	-21	MET	-	initiating methionine	UNP P09622
D	-20	ALA	-	expression tag	UNP P09622
D	-19	SER	-	expression tag	UNP P09622
D	-18	TRP	-	expression tag	UNP P09622
D	-17	SER	-	expression tag	UNP P09622
D	-16	HIS	-	expression tag	UNP P09622
D	-15	PRO	-	expression tag	UNP P09622
D	-14	GLN	-	expression tag	UNP P09622
D	-13	PHE	-	expression tag	UNP P09622
D	-12	GLU	-	expression tag	UNP P09622
D	-11	LYS	-	expression tag	UNP P09622
D	-10	GLY	-	expression tag	UNP P09622
D	-9	ALA	-	expression tag	UNP P09622
D	-8	LEU	-	expression tag	UNP P09622
D	-7	GLU	-	expression tag	UNP P09622
D	-6	VAL	-	expression tag	UNP P09622
D	-5	LEU	-	expression tag	UNP P09622
D	-4	PHE	-	expression tag	UNP P09622
D	-3	GLN	-	expression tag	UNP P09622
D	-2	GLY	-	expression tag	UNP P09622
D	-1	PRO	-	expression tag	UNP P09622
D	0	GLY	-	expression tag	UNP P09622
D	453	LEU	PRO	engineered mutation	UNP P09622
E	-21	MET	-	initiating methionine	UNP P09622
E	-20	ALA	-	expression tag	UNP P09622
E	-19	SER	-	expression tag	UNP P09622
E	-18	TRP	-	expression tag	UNP P09622
E	-17	SER	-	expression tag	UNP P09622

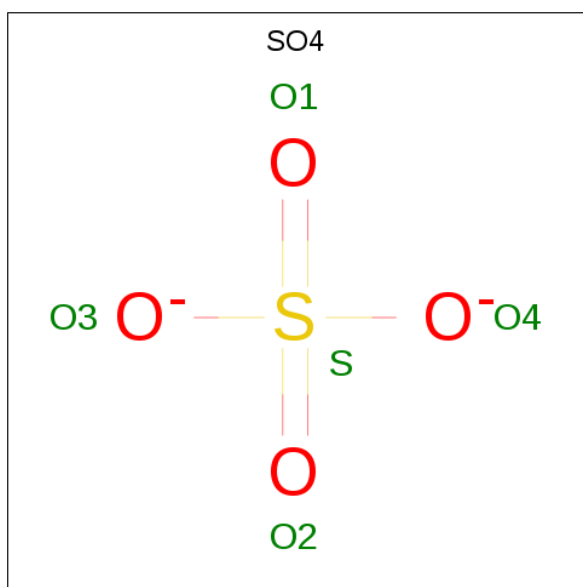*Continued on next page...*

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Chain	Residue	Modelled	Actual	Comment	Reference
E	-16	HIS	-	expression tag	UNP P09622
E	-15	PRO	-	expression tag	UNP P09622
E	-14	GLN	-	expression tag	UNP P09622
E	-13	PHE	-	expression tag	UNP P09622
E	-12	GLU	-	expression tag	UNP P09622
E	-11	LYS	-	expression tag	UNP P09622
E	-10	GLY	-	expression tag	UNP P09622
E	-9	ALA	-	expression tag	UNP P09622
E	-8	LEU	-	expression tag	UNP P09622
E	-7	GLU	-	expression tag	UNP P09622
E	-6	VAL	-	expression tag	UNP P09622
E	-5	LEU	-	expression tag	UNP P09622
E	-4	PHE	-	expression tag	UNP P09622
E	-3	GLN	-	expression tag	UNP P09622
E	-2	GLY	-	expression tag	UNP P09622
E	-1	PRO	-	expression tag	UNP P09622
E	0	GLY	-	expression tag	UNP P09622
E	453	LEU	PRO	engineered mutation	UNP P09622
F	-21	MET	-	initiating methionine	UNP P09622
F	-20	ALA	-	expression tag	UNP P09622
F	-19	SER	-	expression tag	UNP P09622
F	-18	TRP	-	expression tag	UNP P09622
F	-17	SER	-	expression tag	UNP P09622
F	-16	HIS	-	expression tag	UNP P09622
F	-15	PRO	-	expression tag	UNP P09622
F	-14	GLN	-	expression tag	UNP P09622
F	-13	PHE	-	expression tag	UNP P09622
F	-12	GLU	-	expression tag	UNP P09622
F	-11	LYS	-	expression tag	UNP P09622
F	-10	GLY	-	expression tag	UNP P09622
F	-9	ALA	-	expression tag	UNP P09622
F	-8	LEU	-	expression tag	UNP P09622
F	-7	GLU	-	expression tag	UNP P09622
F	-6	VAL	-	expression tag	UNP P09622
F	-5	LEU	-	expression tag	UNP P09622
F	-4	PHE	-	expression tag	UNP P09622
F	-3	GLN	-	expression tag	UNP P09622
F	-2	GLY	-	expression tag	UNP P09622
F	-1	PRO	-	expression tag	UNP P09622
F	0	GLY	-	expression tag	UNP P09622
F	453	LEU	PRO	engineered mutation	UNP P09622
G	-21	MET	-	initiating methionine	UNP P09622

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Chain	Residue	Modelled	Actual	Comment	Reference
G	-20	ALA	-	expression tag	UNP P09622
G	-19	SER	-	expression tag	UNP P09622
G	-18	TRP	-	expression tag	UNP P09622
G	-17	SER	-	expression tag	UNP P09622
G	-16	HIS	-	expression tag	UNP P09622
G	-15	PRO	-	expression tag	UNP P09622
G	-14	GLN	-	expression tag	UNP P09622
G	-13	PHE	-	expression tag	UNP P09622
G	-12	GLU	-	expression tag	UNP P09622
G	-11	LYS	-	expression tag	UNP P09622
G	-10	GLY	-	expression tag	UNP P09622
G	-9	ALA	-	expression tag	UNP P09622
G	-8	LEU	-	expression tag	UNP P09622
G	-7	GLU	-	expression tag	UNP P09622
G	-6	VAL	-	expression tag	UNP P09622
G	-5	LEU	-	expression tag	UNP P09622
G	-4	PHE	-	expression tag	UNP P09622
G	-3	GLN	-	expression tag	UNP P09622
G	-2	GLY	-	expression tag	UNP P09622
G	-1	PRO	-	expression tag	UNP P09622
G	0	GLY	-	expression tag	UNP P09622
G	453	LEU	PRO	engineered mutation	UNP P09622
H	-21	MET	-	initiating methionine	UNP P09622
H	-20	ALA	-	expression tag	UNP P09622
H	-19	SER	-	expression tag	UNP P09622
H	-18	TRP	-	expression tag	UNP P09622
H	-17	SER	-	expression tag	UNP P09622
H	-16	HIS	-	expression tag	UNP P09622
H	-15	PRO	-	expression tag	UNP P09622
H	-14	GLN	-	expression tag	UNP P09622
H	-13	PHE	-	expression tag	UNP P09622
H	-12	GLU	-	expression tag	UNP P09622
H	-11	LYS	-	expression tag	UNP P09622
H	-10	GLY	-	expression tag	UNP P09622
H	-9	ALA	-	expression tag	UNP P09622
H	-8	LEU	-	expression tag	UNP P09622
H	-7	GLU	-	expression tag	UNP P09622
H	-6	VAL	-	expression tag	UNP P09622
H	-5	LEU	-	expression tag	UNP P09622
H	-4	PHE	-	expression tag	UNP P09622
H	-3	GLN	-	expression tag	UNP P09622
H	-2	GLY	-	expression tag	UNP P09622

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Chain	Residue	Modelled	Actual	Comment	Reference
H	-1	PRO	-	expression tag	UNP P09622
H	0	GLY	-	expression tag	UNP P09622
H	453	LEU	PRO	engineered mutation	UNP P09622

- Molecule 2 is FLAVIN-ADENINE DINUCLEOTIDE (three-letter code: FAD) (formula: $C_{27}H_{33}N_9O_{15}P_2$).

FAD
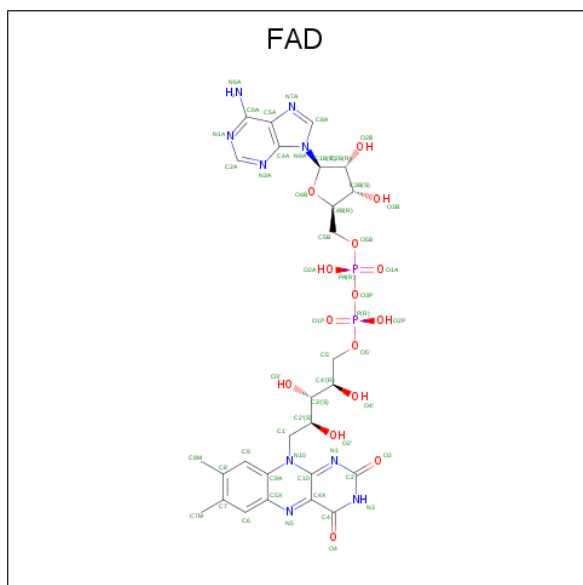
Mol	Chain	Residues	Atoms						ZeroOcc	AltConf
2	A	1	Total	C	H	N	O	P	0	0
			84	27	31	9	15	2		
2	B	1	Total	C	H	N	O	P	0	0
			84	27	31	9	15	2		
2	C	1	Total	C	H	N	O	P	0	0
			84	27	31	9	15	2		
2	D	1	Total	C	H	N	O	P	0	0
			84	27	31	9	15	2		
2	E	1	Total	C	H	N	O	P	0	0
			84	27	31	9	15	2		
2	F	1	Total	C	H	N	O	P	0	0
			84	27	31	9	15	2		
2	G	1	Total	C	H	N	O	P	0	0
			84	27	31	9	15	2		
2	H	1	Total	C	H	N	O	P	0	0
			84	27	31	9	15	2		

- Molecule 3 is SULFATE ION (three-letter code: SO4) (formula: O_4S).

Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total 5	O 4	S 1	0	0
3	A	1	Total 5	O 4	S 1	0	0
3	A	1	Total 5	O 4	S 1	0	0
3	A	1	Total 5	O 4	S 1	0	0
3	A	1	Total 5	O 4	S 1	0	0
3	B	1	Total 5	O 4	S 1	0	0
3	B	1	Total 5	O 4	S 1	0	0
3	C	1	Total 5	O 4	S 1	0	0
3	C	1	Total 5	O 4	S 1	0	0
3	C	1	Total 5	O 4	S 1	0	0
3	C	1	Total 5	O 4	S 1	0	0
3	C	1	Total 5	O 4	S 1	0	0
3	C	1	Total 5	O 4	S 1	0	0
3	D	1	Total 5	O 4	S 1	0	0

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Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	D	1	Total 5	O 4	S 1	0	0
3	D	1	Total 5	O 4	S 1	0	0
3	D	1	Total 5	O 4	S 1	0	0
3	E	1	Total 5	O 4	S 1	0	0
3	E	1	Total 5	O 4	S 1	0	0
3	E	1	Total 5	O 4	S 1	0	0
3	F	1	Total 5	O 4	S 1	0	0
3	F	1	Total 5	O 4	S 1	0	0
3	G	1	Total 5	O 4	S 1	0	0
3	G	1	Total 5	O 4	S 1	0	0
3	G	1	Total 5	O 4	S 1	0	0
3	H	1	Total 5	O 4	S 1	0	0
3	H	1	Total 5	O 4	S 1	0	0

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	124	Total 124	O 124	0	0
4	B	32	Total 32	O 32	0	0
4	C	120	Total 120	O 120	0	0
4	D	28	Total 28	O 28	0	0
4	E	41	Total 41	O 41	0	0
4	F	33	Total 33	O 33	0	0

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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	G	40	Total 40	O 40	0	0
4	H	34	Total 34	O 34	0	0

3 Residue-property plots ⓘ

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density (RSRZ > 2). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.
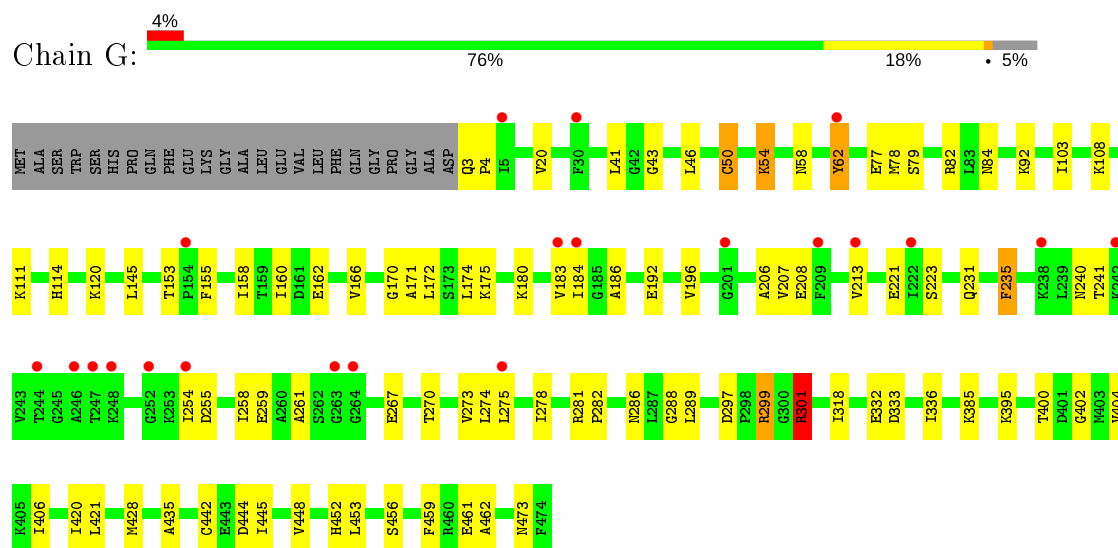
- Molecule 1: Dihydrolipoyl dehydrogenase, mitochondrial

Chain A:
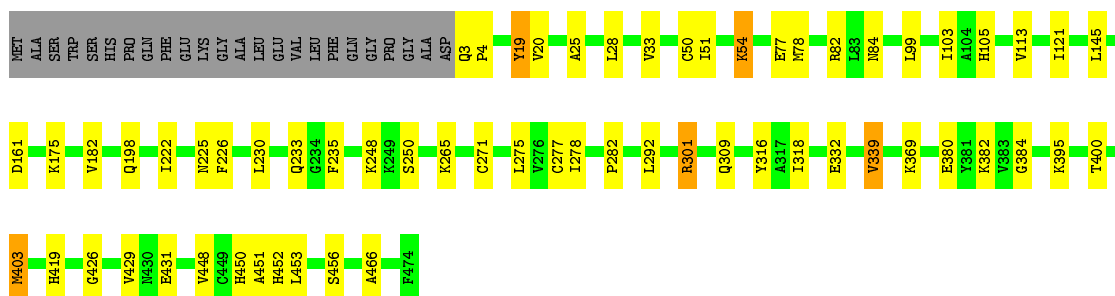
- Molecule 1: Dihydrolipoyl dehydrogenase, mitochondrial

Chain B:
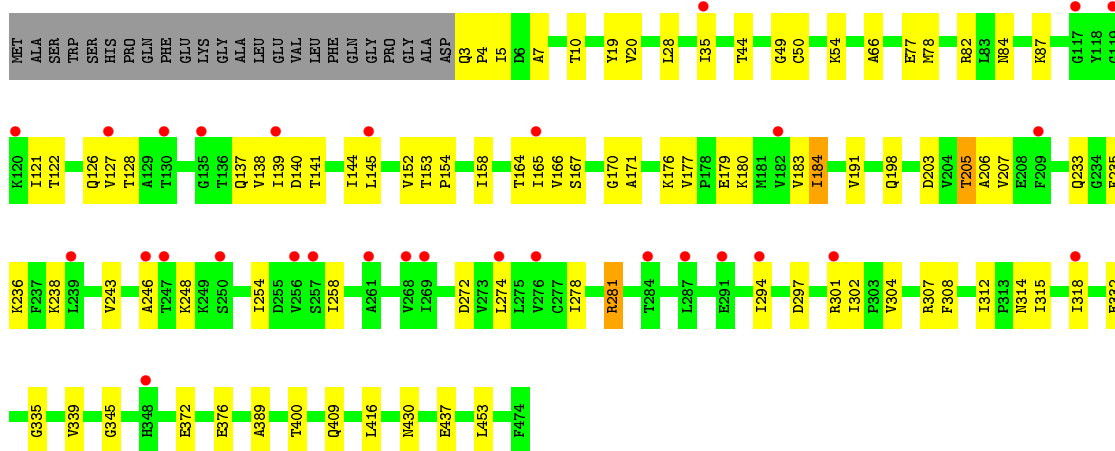
- Molecule 1: Dihydrolipoyl dehydrogenase, mitochondrial

Chain C:
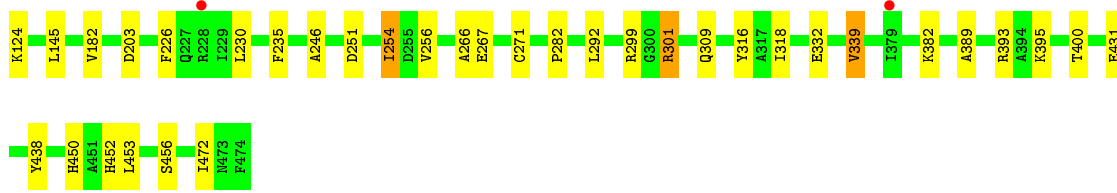
• Molecule 1: Dihydrolipoyl dehydrogenase, mitochondrial
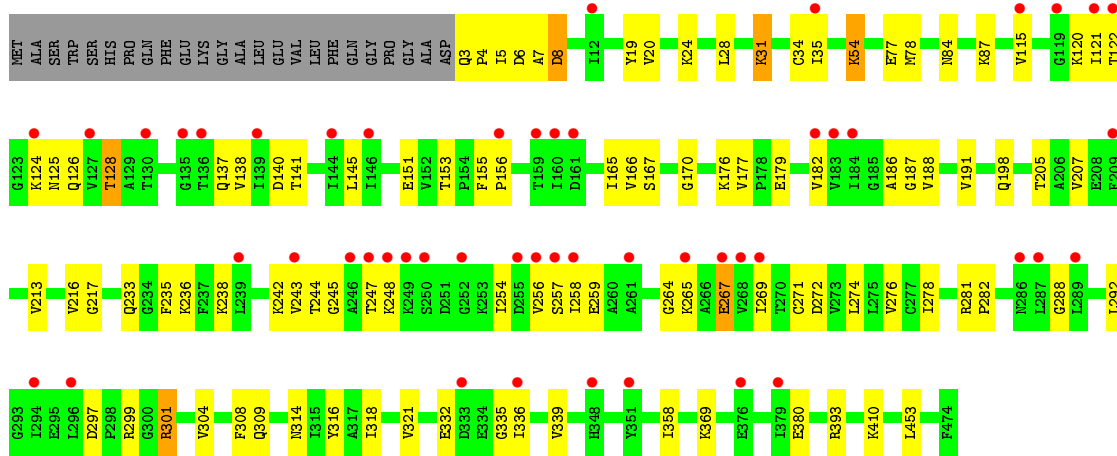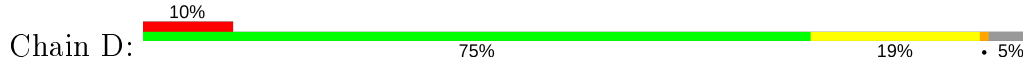
Chain D:

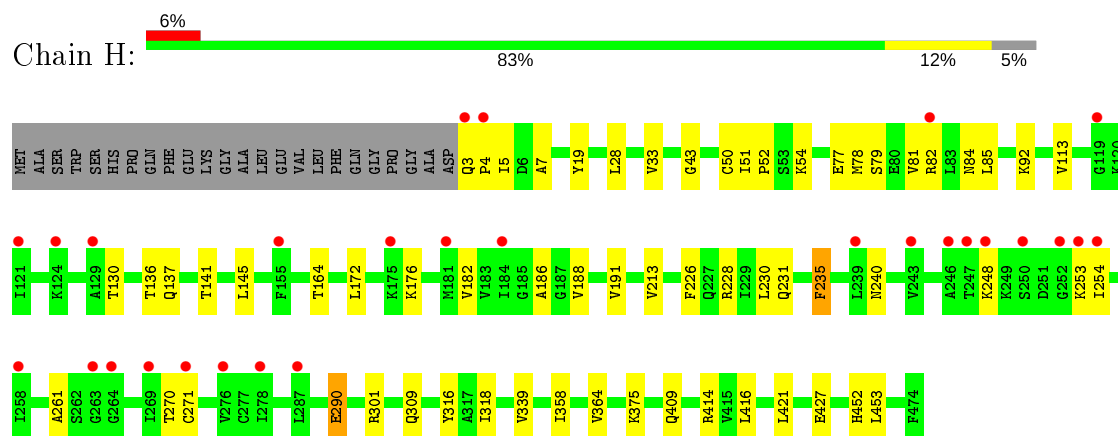• Molecule 1: Dihydrolipoyl dehydrogenase, mitochondrial

Chain E:

• Molecule 1: Dihydrolipoyl dehydrogenase, mitochondrial

Chain F:

- Molecule 1: Dihydrolipoyl dehydrogenase, mitochondrial

Chain G:

- Molecule 1: Dihydrolipoyl dehydrogenase, mitochondrial

Chain H:
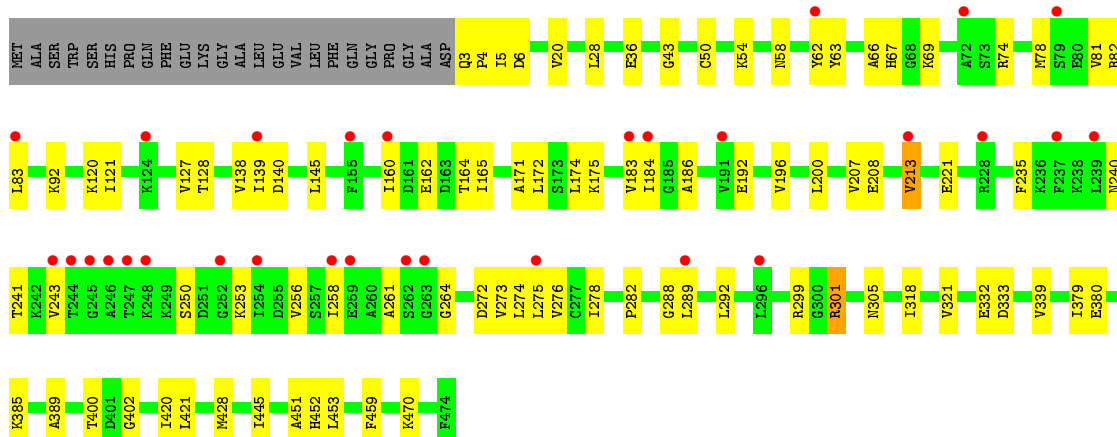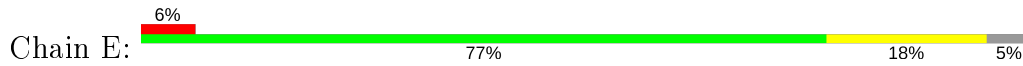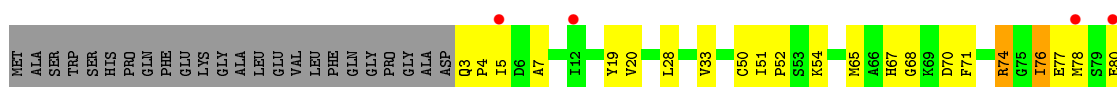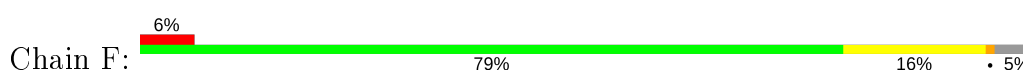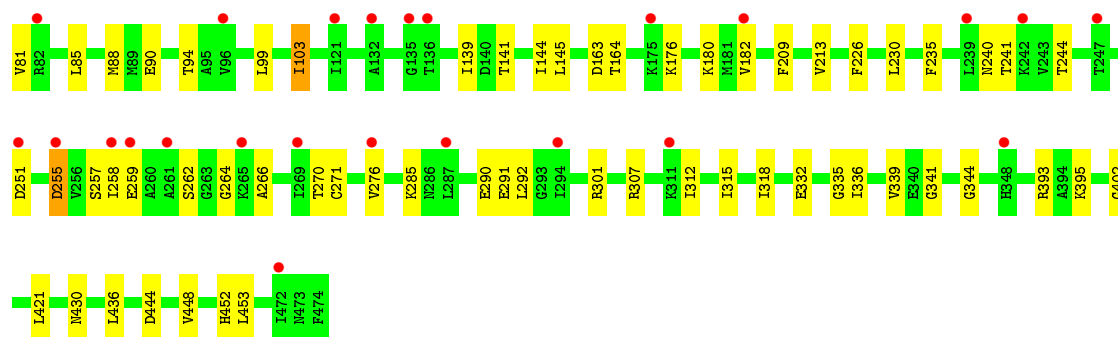
4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α, β, γ	55.56Å 123.39Å 158.41Å 105.95° 91.31° 90.00°	Depositor
Resolution (Å)	46.57 – 2.34	Depositor
	46.57 – 2.34	EDS
% Data completeness	96.6 (46.57-2.34)	Depositor
(in resolution range)	96.6 (46.57-2.34)	EDS
R_{merge}	0.14	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.30 (at 2.34Å)	Xtriage
Refinement program	PHENIX	Depositor
R, R_{free}	0.227 , 0.249	Depositor
	0.228 , 0.249	DCC
R_{free} test set	2468 reflections (1.50%)	wwPDB-VP
Wilson B-factor (Å^2)	40.2	Xtriage
Anisotropy	0.314	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.38 , 32.6	EDS
L-test for twinning [2]	$< |L| > = 0.50, < L^2 > = 0.33$	Xtriage
Estimated twinning fraction	0.104 for h,-k,-l	Xtriage
F_o,F_c correlation	0.93	EDS
Total number of atoms	57894	wwPDB-VP
Average B, all atoms (Å^2)	64.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.83% of the height of the origin peak. No significant pseudotranslation is detected.*

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[1]Intensities estimated from amplitudes.
[2]Theoretical values of $< |L| >$, $< L^2 >$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality (i)

5.1 Standard geometry (i)

Bond lengths and bond angles in the following residue types are not validated in this section: SO4, FAD

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	#$|Z| > 5$	RMSZ	#$|Z| > 5$
1	A	0.61	1/3571 (0.0%)	0.63	0/4821
1	B	0.58	2/3571 (0.1%)	0.68	3/4821 (0.1%)
1	C	0.62	1/3562 (0.0%)	0.65	0/4809
1	D	0.54	0/3562	0.63	1/4809 (0.0%)
1	E	0.45	0/3571	0.61	1/4821 (0.0%)
1	F	0.51	1/3562 (0.0%)	0.69	2/4809 (0.0%)
1	G	0.52	1/3562 (0.0%)	0.64	4/4809 (0.1%)
1	H	0.51	2/3562 (0.1%)	0.62	2/4809 (0.0%)
All	All	0.55	8/28523 (0.0%)	0.64	13/38508 (0.0%)

The worst 5 of 8 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	281	ARG	CZ-NH2	-12.86	1.16	1.33
1	F	255	ASP	CG-OD1	-8.87	1.04	1.25
1	G	442	CYS	CB-SG	7.36	1.94	1.82
1	A	277	CYS	CB-SG	-6.59	1.71	1.82
1	H	82	ARG	CZ-NH1	-5.93	1.25	1.33

The worst 5 of 13 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	F	255	ASP	CB-CG-OD2	21.13	137.32	118.30
1	B	281	ARG	NE-CZ-NH1	20.04	130.32	120.30
1	F	255	ASP	CB-CG-OD1	-13.69	105.98	118.30
1	G	301	ARG	NE-CZ-NH2	-12.26	114.17	120.30
1	H	82	ARG	NE-CZ-NH2	11.86	126.23	120.30

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts (i)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	3514	3573	3572	43	0
1	B	3514	3572	3572	72	0
1	C	3508	3567	3566	32	0
1	D	3508	3567	3566	97	0
1	E	3514	3572	3572	67	0
1	F	3508	3567	3566	54	0
1	G	3508	3568	3566	77	0
1	H	3508	3567	3566	41	0
2	A	53	31	31	0	0
2	B	53	31	31	1	0
2	C	53	31	31	1	0
2	D	53	31	31	1	0
2	E	53	31	31	2	0
2	F	53	31	31	0	0
2	G	53	31	31	1	0
2	H	53	31	31	2	0
3	A	25	0	0	1	0
3	B	10	0	0	0	0
3	C	30	0	0	3	0
3	D	20	0	0	0	0
3	E	15	0	0	4	0
3	F	10	0	0	1	0
3	G	15	0	0	2	0
3	H	10	0	0	1	0
4	A	124	0	0	0	0
4	B	32	0	0	3	0
4	C	120	0	0	1	0
4	D	28	0	0	2	0
4	E	41	0	0	3	0
4	F	33	0	0	3	0
4	G	40	0	0	0	0
4	H	34	0	0	1	0
All	All	29093	28801	28794	453	0

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 8.

The worst 5 of 453 close contacts within the same asymmetric unit are listed below, sorted by

their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:F:259:GLU:HG2	1:F:266:ALA:HA	1.48	0.92
1:D:176:LYS:HD3	1:D:177:VAL:N	1.91	0.86
1:D:176:LYS:HD3	1:D:177:VAL:H	1.41	0.84
1:D:128:THR:HG22	1:D:138:VAL:HG22	1.63	0.80
1:E:164:THR:HG23	1:E:165:ILE:HD12	1.65	0.79

There are no symmetry-related clashes.

5.3 Torsion angles ⓘ

5.3.1 Protein backbone ⓘ

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	471/496 (95%)	464 (98%)	7 (2%)	0	100	100
1	B	471/496 (95%)	464 (98%)	7 (2%)	0	100	100
1	C	470/496 (95%)	461 (98%)	9 (2%)	0	100	100
1	D	470/496 (95%)	459 (98%)	11 (2%)	0	100	100
1	E	471/496 (95%)	459 (98%)	12 (2%)	0	100	100
1	F	470/496 (95%)	461 (98%)	9 (2%)	0	100	100
1	G	470/496 (95%)	459 (98%)	11 (2%)	0	100	100
1	H	470/496 (95%)	458 (97%)	12 (3%)	0	100	100
All	All	3763/3968 (95%)	3685 (98%)	78 (2%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains ⓘ

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	373/390 (96%)	358 (96%)	15 (4%)	31	40
1	B	373/390 (96%)	363 (97%)	10 (3%)	44	55
1	C	372/390 (95%)	360 (97%)	12 (3%)	39	47
1	D	372/390 (95%)	360 (97%)	12 (3%)	39	47
1	E	373/390 (96%)	362 (97%)	11 (3%)	42	52
1	F	372/390 (95%)	358 (96%)	14 (4%)	33	41
1	G	372/390 (95%)	365 (98%)	7 (2%)	57	68
1	H	372/390 (95%)	365 (98%)	7 (2%)	57	68
All	All	2979/3120 (96%)	2891 (97%)	88 (3%)	41	50

5 of 88 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	31	LYS
1	E	50	CYS
1	H	19	TYR
1	D	54	LYS
1	D	216	VAL

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	B	430	ASN
1	C	231	GLN
1	F	137	GLN

5.3.3   RNA (i)

There are no RNA molecules in this entry.

5.4   Non-standard residues in protein, DNA, RNA chains (i)

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates (i)

There are no carbohydrates in this entry.

5.6 Ligand geometry (i)

35 ligands are modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	#$|Z| > 2$	Counts	RMSZ	#$|Z| > 2$
3	SO4	B	503	-	4,4,4	0.20	0	6,6,6	0.14	0
3	SO4	C	504	-	4,4,4	0.17	0	6,6,6	0.13	0
3	SO4	A	506	-	4,4,4	0.16	0	6,6,6	0.10	0
3	SO4	D	504	-	4,4,4	0.20	0	6,6,6	0.08	0
3	SO4	C	506	-	4,4,4	0.33	0	6,6,6	0.28	0
3	SO4	A	502	-	4,4,4	0.12	0	6,6,6	0.34	0
3	SO4	A	505	-	4,4,4	0.17	0	6,6,6	0.15	0
3	SO4	D	503	-	4,4,4	0.12	0	6,6,6	0.09	0
3	SO4	E	503	-	4,4,4	0.17	0	6,6,6	0.16	0
3	SO4	A	503	-	4,4,4	0.21	0	6,6,6	0.22	0
3	SO4	B	502	-	4,4,4	0.13	0	6,6,6	0.11	0
3	SO4	A	504	-	4,4,4	0.23	0	6,6,6	0.07	0
3	SO4	D	502	-	4,4,4	0.16	0	6,6,6	0.11	0
3	SO4	H	503	-	4,4,4	0.08	0	6,6,6	0.20	0
2	FAD	H	501	-	51,58,58	1.28	6 (11%)	60,89,89	2.22	7 (11%)
2	FAD	A	501	-	51,58,58	1.23	5 (9%)	60,89,89	2.10	7 (11%)
3	SO4	C	505	-	4,4,4	0.10	0	6,6,6	0.10	0
2	FAD	C	501	-	51,58,58	1.03	3 (5%)	60,89,89	2.19	7 (11%)
3	SO4	F	502	-	4,4,4	0.14	0	6,6,6	0.18	0
3	SO4	D	505	-	4,4,4	0.13	0	6,6,6	0.14	0
2	FAD	B	501	-	51,58,58	1.28	6 (11%)	60,89,89	2.22	8 (13%)
3	SO4	E	502	-	4,4,4	0.16	0	6,6,6	0.11	0
3	SO4	G	502	-	4,4,4	0.15	0	6,6,6	0.20	0
3	SO4	C	503	-	4,4,4	0.13	0	6,6,6	0.11	0
3	SO4	E	504	-	4,4,4	0.21	0	6,6,6	0.07	0
3	SO4	C	507	-	4,4,4	0.18	0	6,6,6	0.12	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	#|Z| > 2	Counts	RMSZ	#|Z| > 2
2	FAD	E	501	-	51,58,58	1.25	5 (9%)	60,89,89	2.23	6 (10%)
2	FAD	D	501	-	51,58,58	1.25	6 (11%)	60,89,89	2.21	6 (10%)
3	SO4	C	502	-	4,4,4	0.26	0	6,6,6	0.30	0
3	SO4	F	503	-	4,4,4	0.83	0	6,6,6	1.28	0
3	SO4	G	504	-	4,4,4	0.17	0	6,6,6	0.17	0
3	SO4	G	503	-	4,4,4	0.15	0	6,6,6	0.09	0
2	FAD	G	501	-	51,58,58	1.28	5 (9%)	60,89,89	2.25	7 (11%)
2	FAD	F	501	-	51,58,58	1.30	5 (9%)	60,89,89	2.18	7 (11%)
3	SO4	H	502	-	4,4,4	0.13	0	6,6,6	0.06	0

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	FAD	H	501	-	-	4/30/50/50	0/6/6/6
2	FAD	E	501	-	-	3/30/50/50	0/6/6/6
2	FAD	G	501	-	-	3/30/50/50	0/6/6/6
2	FAD	D	501	-	-	2/30/50/50	0/6/6/6
2	FAD	A	501	-	-	2/30/50/50	0/6/6/6
2	FAD	F	501	-	-	2/30/50/50	0/6/6/6
2	FAD	C	501	-	-	2/30/50/50	0/6/6/6
2	FAD	B	501	-	-	2/30/50/50	0/6/6/6

The worst 5 of 41 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	F	501	FAD	C4X-C10	5.99	1.44	1.38
2	G	501	FAD	C4X-C10	5.98	1.44	1.38
2	E	501	FAD	C4X-C10	5.77	1.44	1.38
2	B	501	FAD	C4X-C10	5.76	1.44	1.38
2	H	501	FAD	C4X-C10	5.75	1.44	1.38

The worst 5 of 55 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	G	501	FAD	C4-N3-C2	13.30	126.37	115.14
2	E	501	FAD	C4-N3-C2	13.02	126.13	115.14

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	D	501	FAD	C4-N3-C2	12.97	126.09	115.14
2	B	501	FAD	C4-N3-C2	12.92	126.05	115.14
2	H	501	FAD	C4-N3-C2	12.88	126.02	115.14

There are no chirality outliers.

5 of 20 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	H	501	FAD	C5'-O5'-P-O1P
2	E	501	FAD	O4B-C4B-C5B-O5B
2	H	501	FAD	O4B-C4B-C5B-O5B
2	B	501	FAD	O4B-C4B-C5B-O5B
2	G	501	FAD	O4B-C4B-C5B-O5B

There are no ring outliers.

14 monomers are involved in 20 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	506	SO4	1	0
3	C	506	SO4	2	0
3	E	503	SO4	1	0
3	H	503	SO4	1	0
2	H	501	FAD	2	0
2	C	501	FAD	1	0
2	B	501	FAD	1	0
3	E	502	SO4	3	0
3	C	507	SO4	1	0
2	E	501	FAD	2	0
2	D	501	FAD	1	0
3	F	503	SO4	1	0
3	G	503	SO4	2	0
2	G	501	FAD	1	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less then 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and
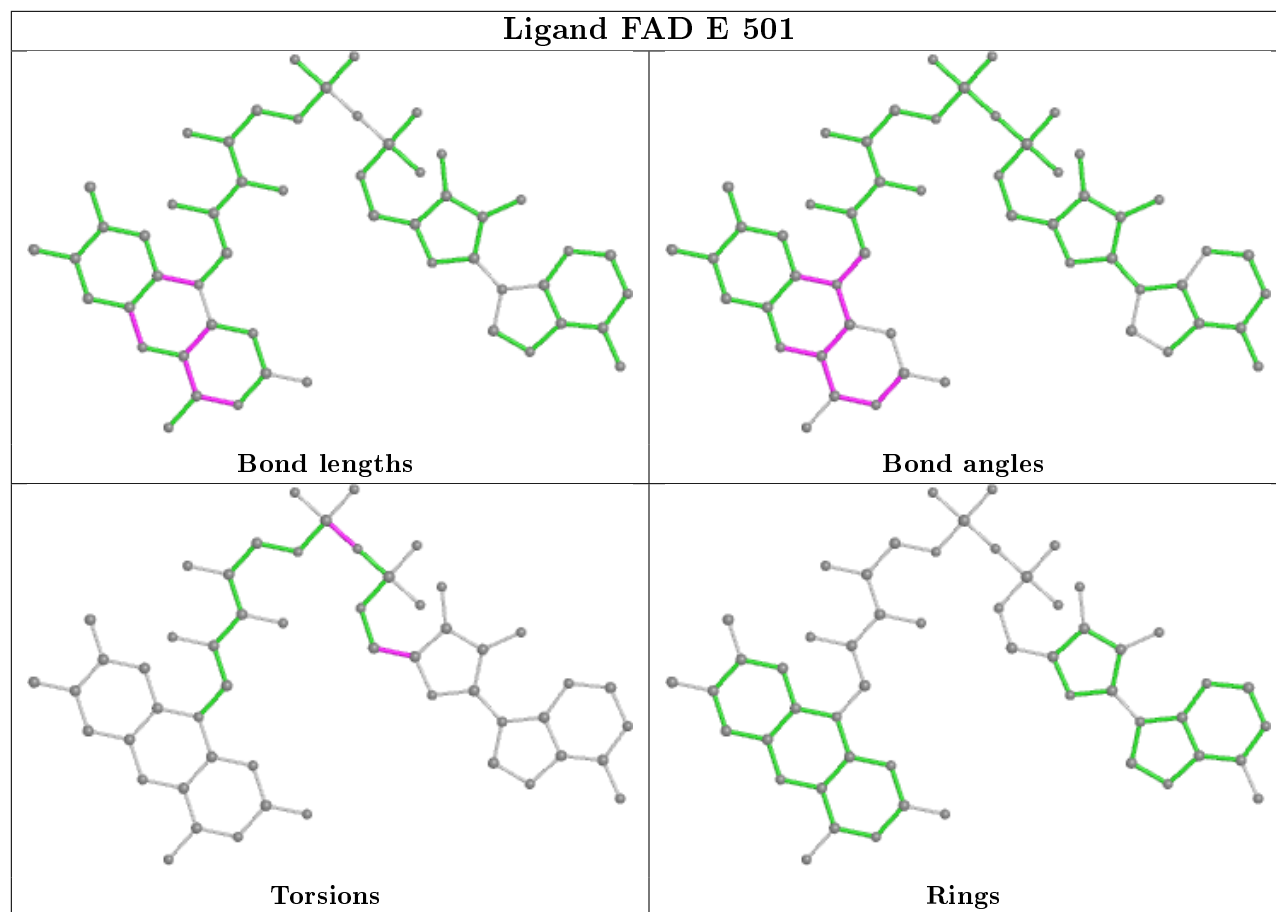
any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.
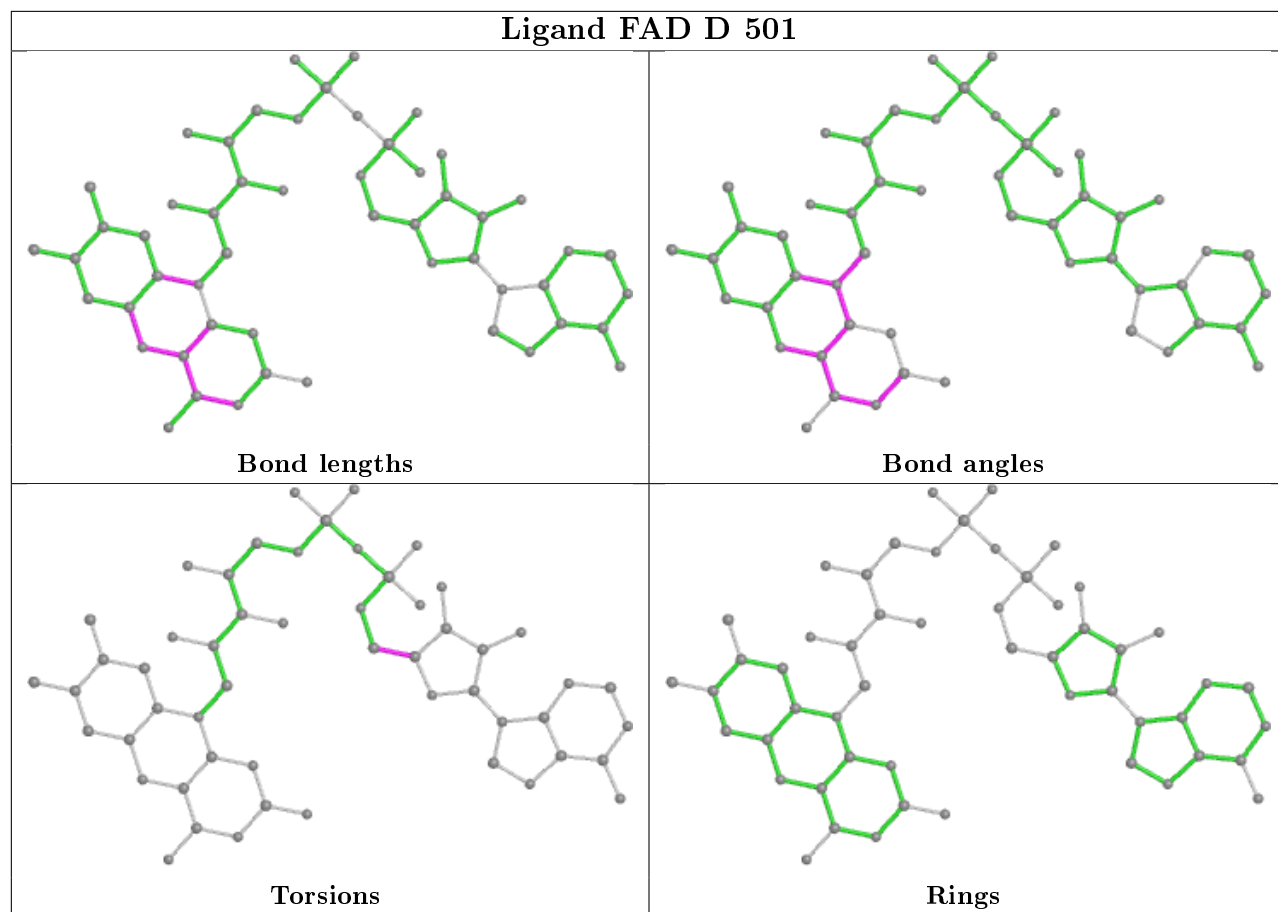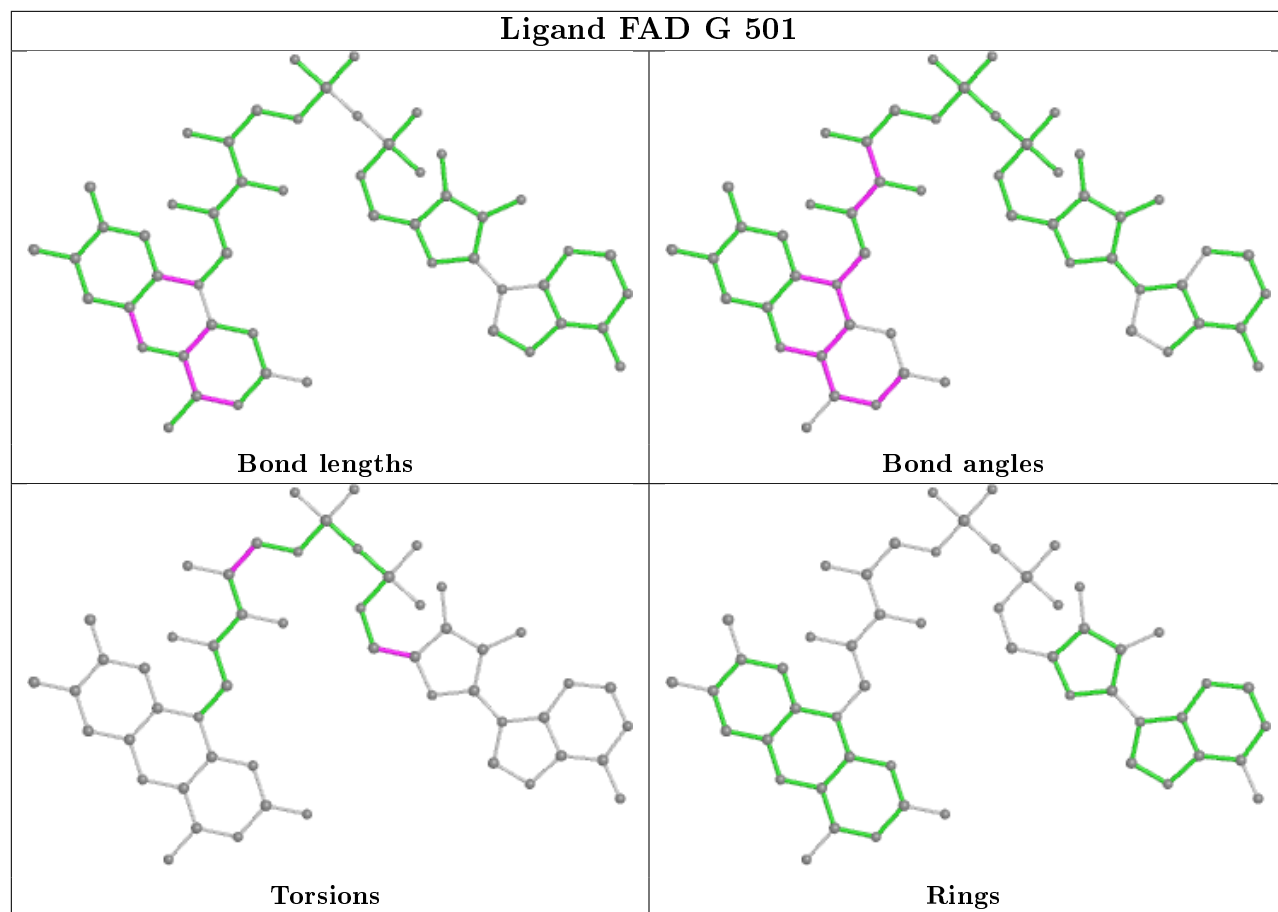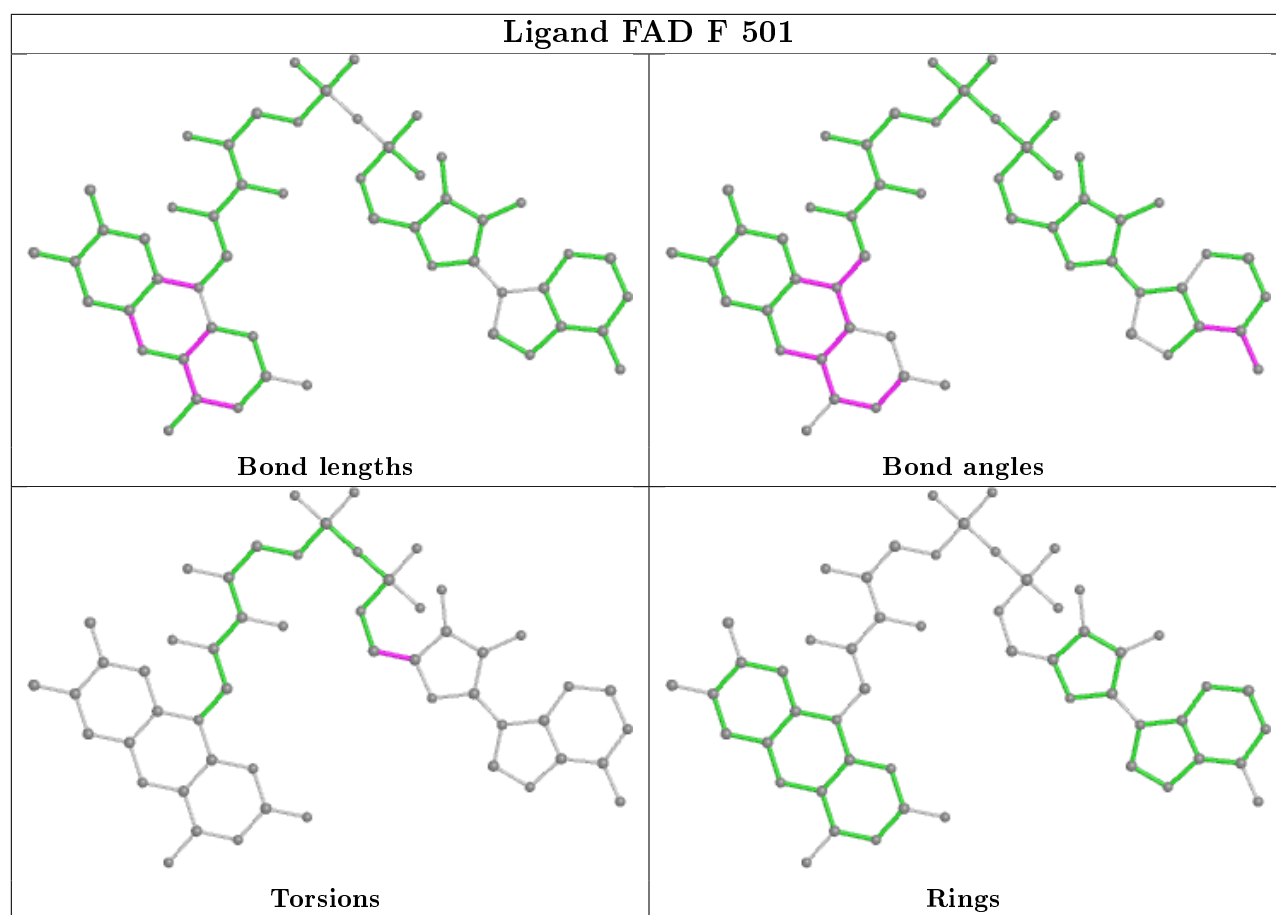
Ligand FAD H 501

Bond lengths

Bond angles

Torsions

Rings

Ligand FAD A 501

Bond lengths

Bond angles

Torsions

Rings

Ligand FAD C 501

Bond lengths

Bond angles

Torsions

Rings

Ligand FAD B 501

Bond lengths

Bond angles

Torsions

Rings

Ligand FAD E 501

Bond lengths

Bond angles

Torsions

Rings

Ligand FAD D 501

Bond lengths

Bond angles

Torsions

Rings

Ligand FAD G 501

Bond lengths

Bond angles

Torsions

Rings

Ligand FAD F 501

Bond lengths

Bond angles

Torsions

Rings

5.7 Other polymers (i)

There are no such residues in this entry.

5.8 Polymer linkage issues (i)

There are no chain breaks in this entry.

6 Fit of model and data (i)

6.1 Protein, DNA and RNA chains (i)

In the following table, the column labelled '#RSRZ> 2' contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95th percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled 'Q< 0.9' lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2			OWAB(Å^2)	Q<0.9
1	A	472/496 (95%)	0.08	0	100	100	23, 35, 58, 85	0
1	B	472/496 (95%)	0.53	30 (6%)	19	27	28, 64, 102, 132	0
1	C	472/496 (95%)	0.16	2 (0%)	92	96	23, 37, 61, 83	0
1	D	472/496 (95%)	0.68	50 (10%)	6	10	29, 67, 109, 134	0
1	E	472/496 (95%)	0.49	30 (6%)	19	27	32, 62, 97, 124	0
1	F	472/496 (95%)	0.52	28 (5%)	22	31	37, 61, 94, 124	0
1	G	472/496 (95%)	0.46	21 (4%)	34	45	32, 61, 97, 123	0
1	H	472/496 (95%)	0.51	28 (5%)	22	31	32, 59, 97, 130	0
All	All	3776/3968 (95%)	0.43	189 (5%)	28	39	23, 56, 97, 134	0

The worst 5 of 189 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	268	VAL	7.6
1	F	132	ALA	7.1
1	D	246	ALA	5.9
1	D	247	THR	5.3
1	F	259	GLU	5.0

6.2 Non-standard residues in protein, DNA, RNA chains (i)

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates (i)

There are no carbohydrates in this entry.

wwPDB X-ray Structure Validation Summary Report

6.4 Ligands (i)

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

| Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
3	SO4	E	503	5/5	0.78	0.16	105,105,106,108	0
3	SO4	G	504	5/5	0.82	0.17	94,94,96,96	0
3	SO4	C	506	5/5	0.84	0.21	56,63,70,70	0
3	SO4	A	505	5/5	0.87	0.17	80,82,83,83	0
3	SO4	F	503	5/5	0.89	0.15	50,53,57,57	5
3	SO4	G	502	5/5	0.89	0.19	89,89,92,93	0
3	SO4	C	503	5/5	0.90	0.17	74,75,76,77	0
3	SO4	C	507	5/5	0.90	0.17	41,42,44,46	5
3	SO4	B	503	5/5	0.91	0.13	96,97,98,99	0
3	SO4	D	505	5/5	0.91	0.14	51,53,56,57	5
3	SO4	E	504	5/5	0.91	0.13	84,84,86,87	0
3	SO4	G	503	5/5	0.91	0.15	90,105,107,108	0
3	SO4	A	506	5/5	0.92	0.12	75,88,90,90	0
3	SO4	E	502	5/5	0.92	0.10	80,97,99,99	0
3	SO4	D	502	5/5	0.92	0.14	100,100,101,101	0
2	FAD	D	501	53/53	0.93	0.16	42,64,81,84	0
3	SO4	B	502	5/5	0.93	0.14	97,98,98,100	0
2	FAD	E	501	53/53	0.94	0.15	28,56,84,88	0
2	FAD	H	501	53/53	0.94	0.14	39,55,67,71	0
3	SO4	C	502	5/5	0.94	0.18	66,66,67,67	0
3	SO4	D	503	5/5	0.94	0.10	98,98,98,99	0
2	FAD	B	501	53/53	0.94	0.15	42,58,74,78	0
3	SO4	D	504	5/5	0.94	0.14	82,83,85,85	0
2	FAD	F	501	53/53	0.94	0.15	36,54,68,76	0
3	SO4	F	502	5/5	0.95	0.12	83,84,84,85	0
3	SO4	A	503	5/5	0.95	0.13	64,64,65,67	0
2	FAD	G	501	53/53	0.95	0.13	29,53,66,68	0
3	SO4	C	504	5/5	0.95	0.12	82,82,84,84	0
3	SO4	H	502	5/5	0.95	0.14	90,91,93,93	0
2	FAD	A	501	53/53	0.97	0.16	15,26,34,40	0
3	SO4	C	505	5/5	0.97	0.10	73,74,76,78	0
2	FAD	C	501	53/53	0.97	0.16	17,26,36,38	0
3	SO4	H	503	5/5	0.97	0.12	49,53,55,60	5
3	SO4	A	504	5/5	0.99	0.10	65,67,70,72	0
3	SO4	A	502	5/5	0.99	0.15	47,48,49,51	0

The following is a graphical depiction of the model fit to experimental electron density of all

instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.
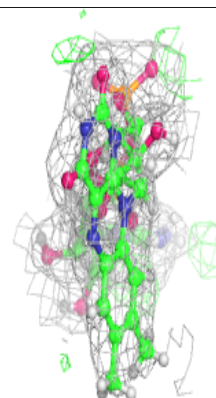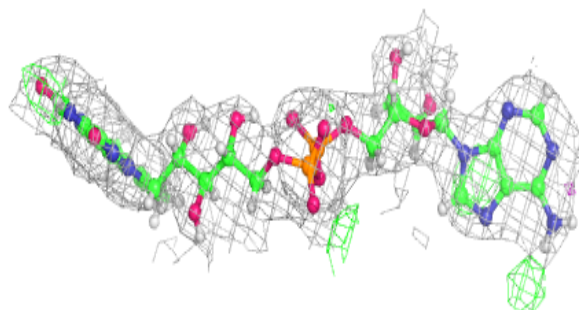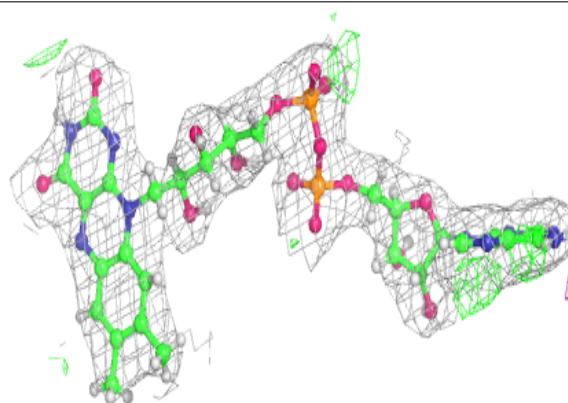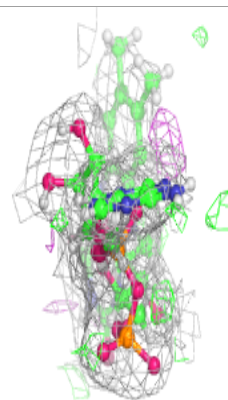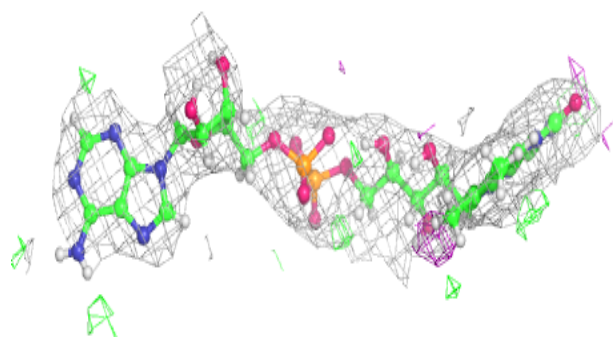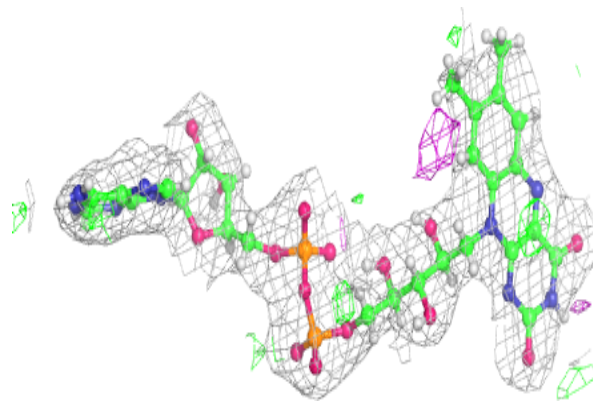
Electron density around FAD D 501:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
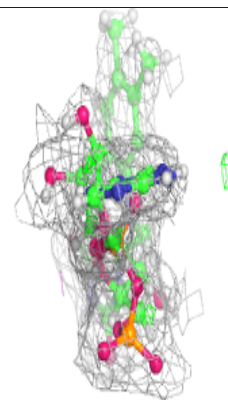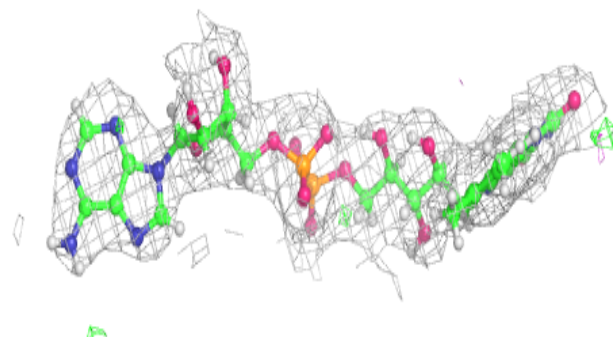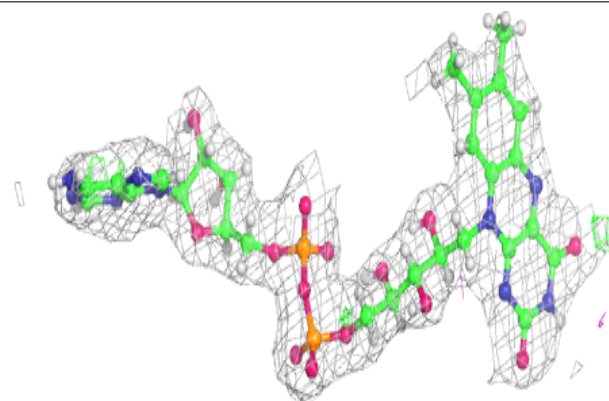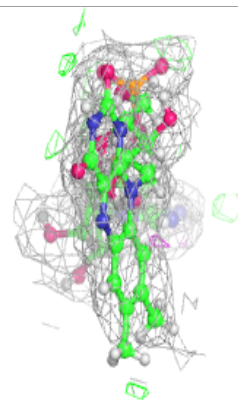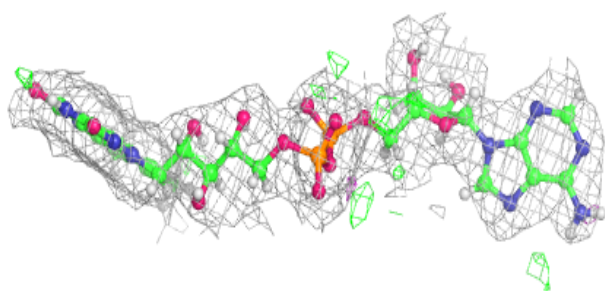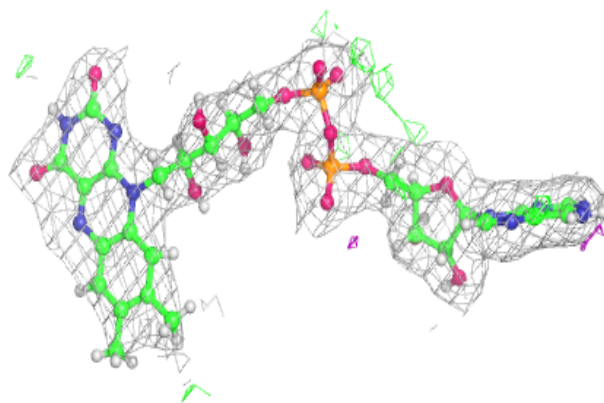$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative)
and green (positive)
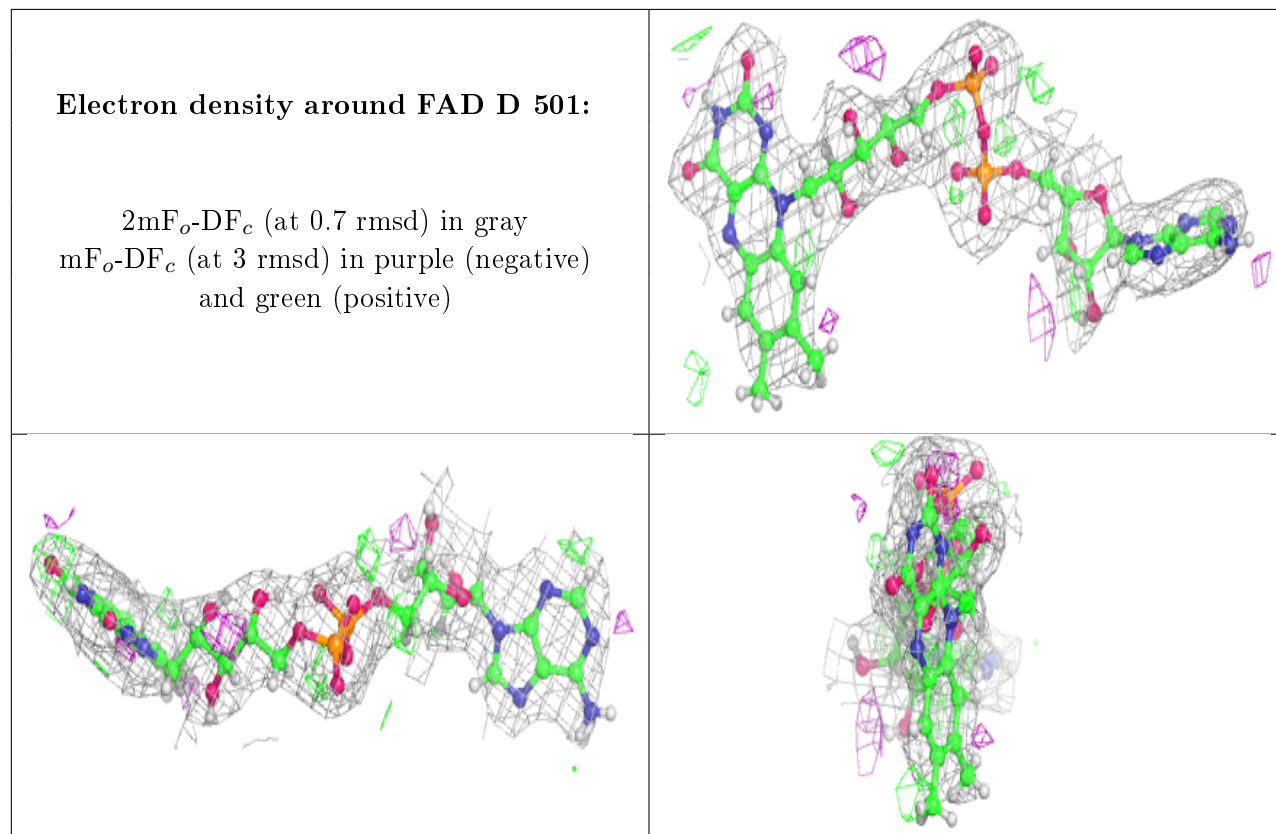
Electron density around FAD E 501:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)
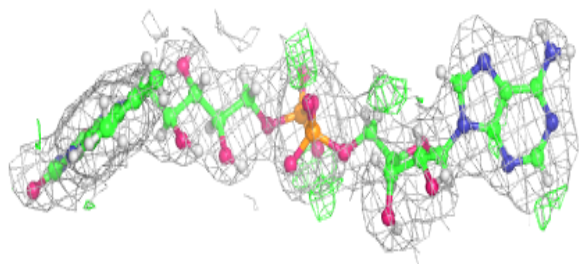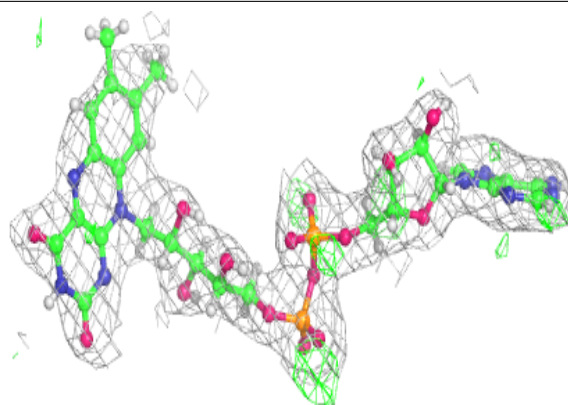
Electron density around FAD H 501:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
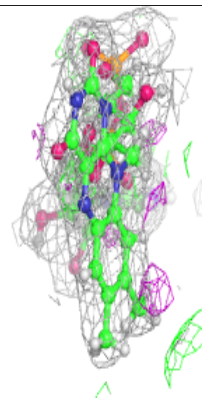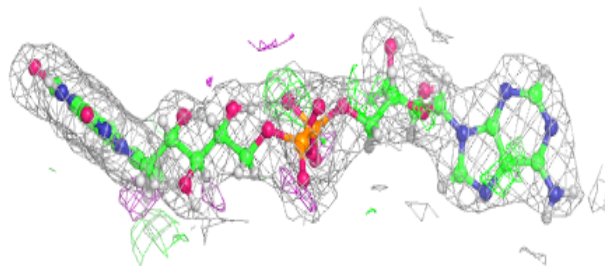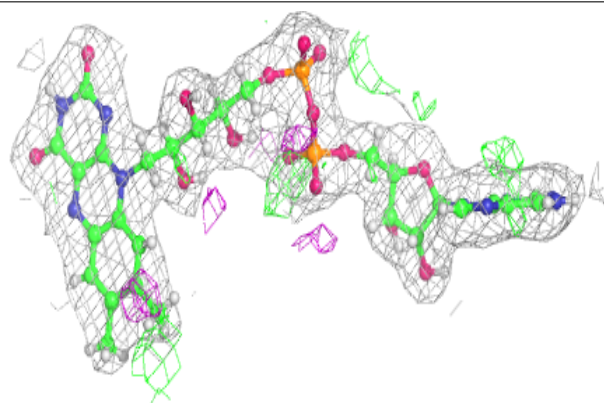mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)

Electron density around FAD B 501:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative)
and green (positive)

Electron density around FAD F 501:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative)
and green (positive)

Electron density around FAD G 501:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative)
and green (positive)

Electron density around FAD A 501:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
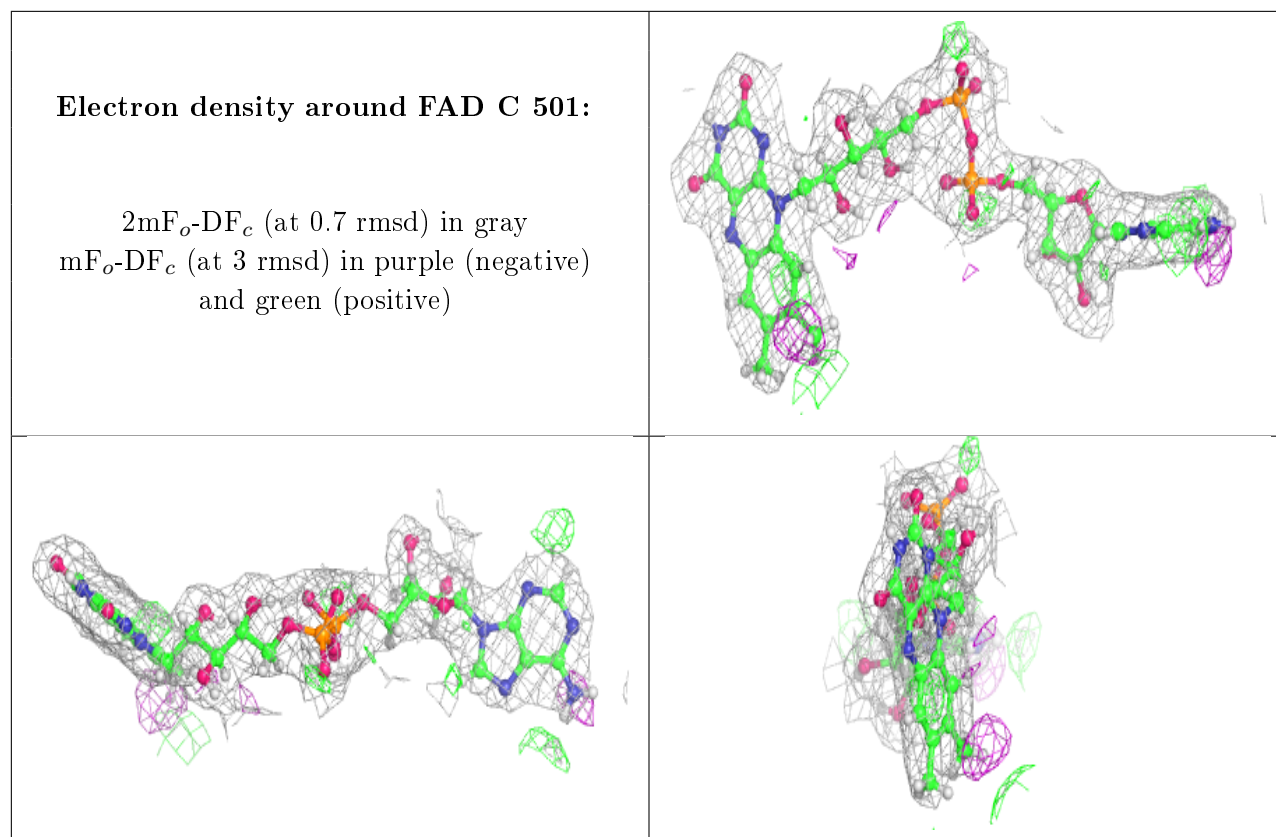$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative)
and green (positive)

Electron density around FAD C 501:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative)
and green (positive)

6.5 Other polymers (i)

There are no such residues in this entry.